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(54) Liquid-type evaporator

(57) The evaporator comprises parallel pairs of finned tubes 10 each of rectangular section and having a partition 9 dividing it into two ducts each of which accommodates a static

turbulence inducer in the form of a zig-zag folded sheet 8 having perforations of zig-zag form. The ends of the tubes 10 project into reservoirs 11, 12 having refrigerant entry and exit openings 14 and 15 respectively.

Fig. 3

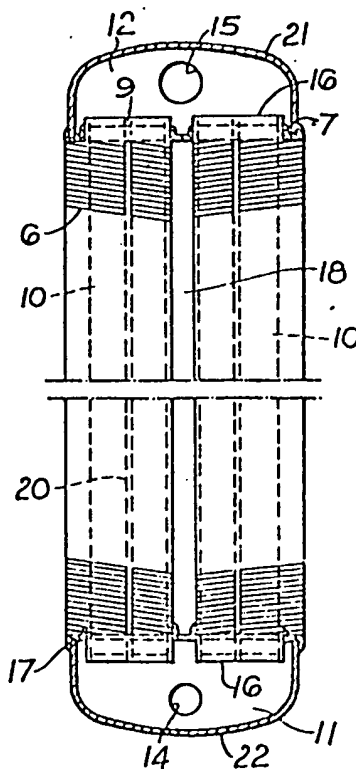
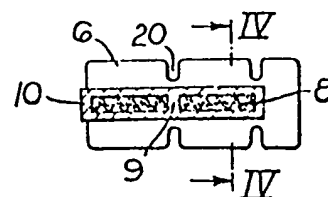


Fig. 5



The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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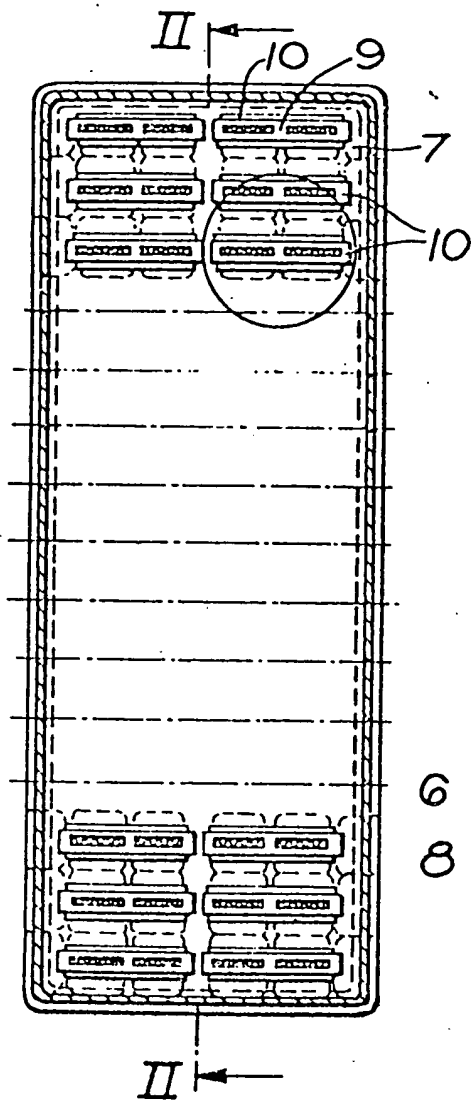


Fig. 1

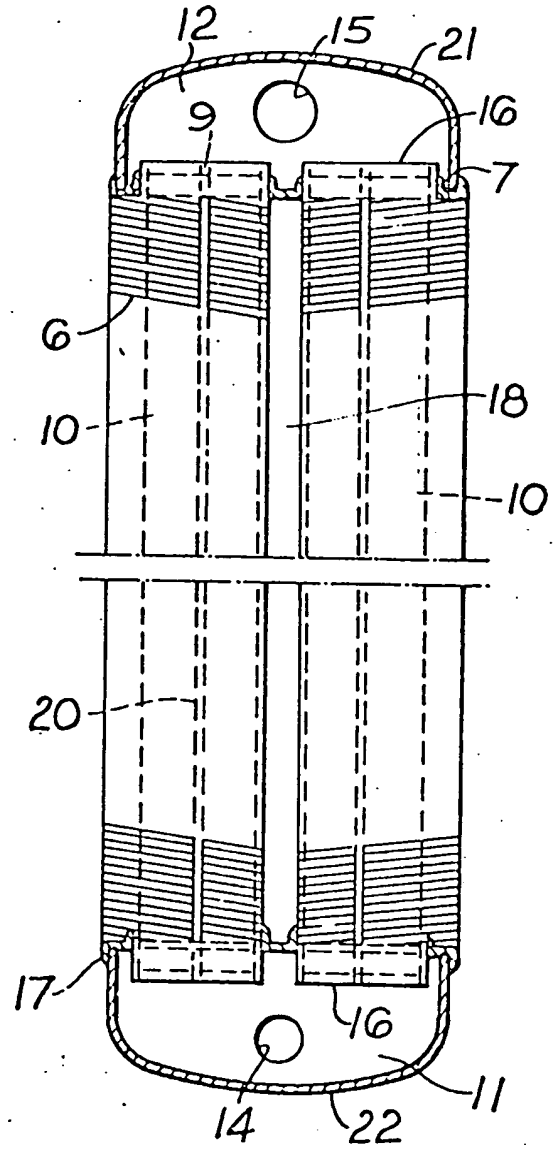


Fig. 3

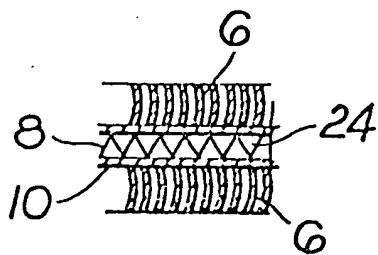


Fig. 4

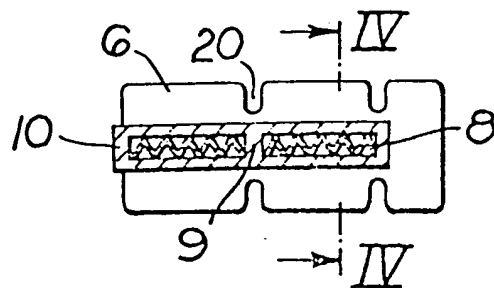


Fig. 5

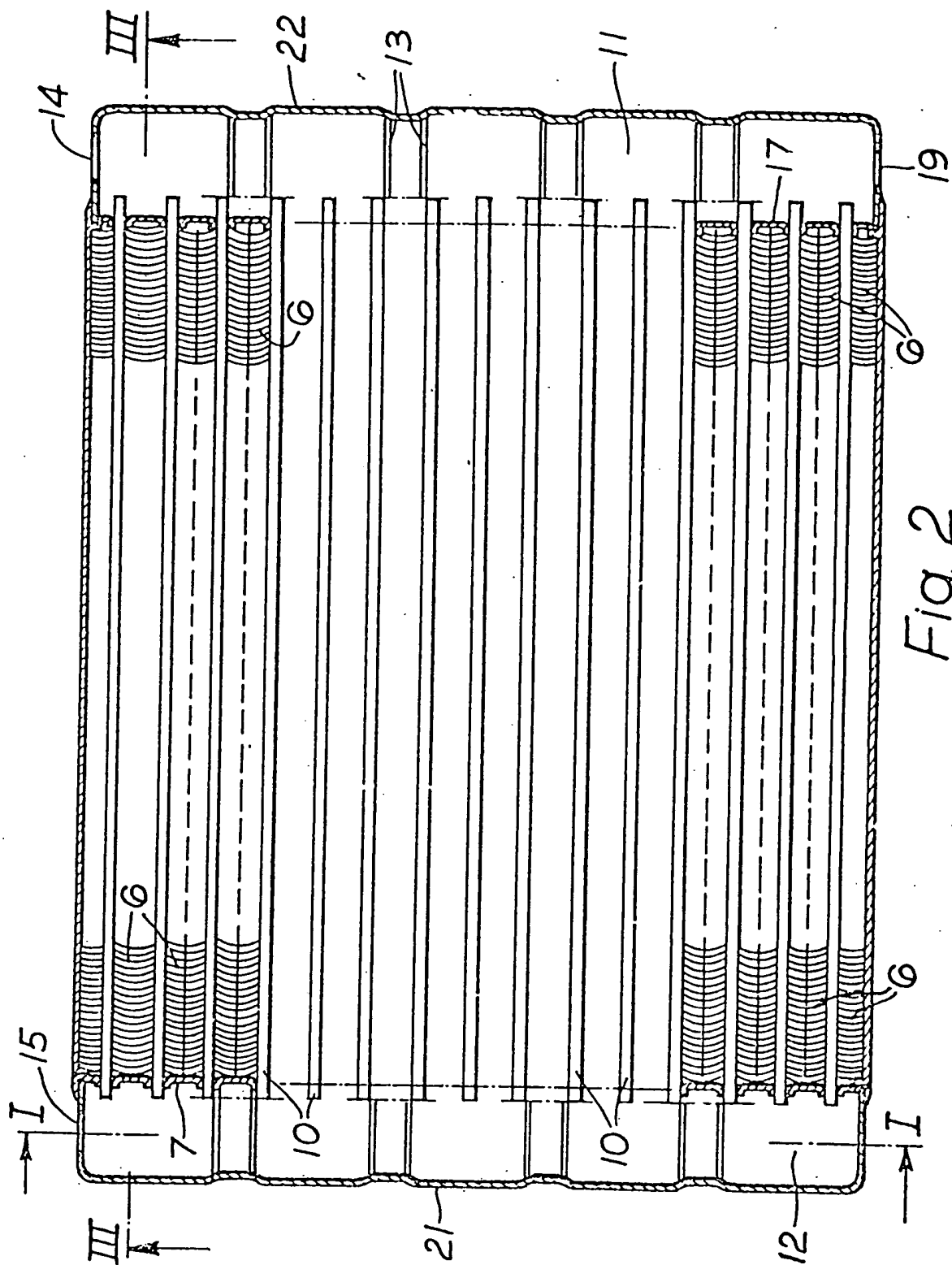


Fig. 2

SPECIFICATION Liquid-type evaporator

This invention concerns a liquid-type evaporator of the kind used for cooling, for instance in air-conditioning apparatus or refrigeration apparatus.

An object of the invention is to provide a construction of such an evaporator which has a significantly improved capacity as compared with the prior known evaporators which generally comprise panels of circular tubes which are in coil form.

Pursuant hereto, the present invention provides a liquid-type evaporator characterised in that it comprises a panel or bank of tubes each having fins joined to them and each containing a static turbulence generator comprising a sheet bent to zig-zag configuration and having along its length perforations in zig-zag form.

In a preferred embodiment of the evaporator, use is made of finned tubes of which the fins are integral, being formed by machining tubular stock. The tubes are rectangular in shape and are formed into a panel by sealing their ends, ~~eg., by welding~~, to head plates which together with respective cover plates, define respective reservoirs at each end of the panel.

To ensure turbulence of refrigerant liquid in boiling during passage through the tubes, a zig-zag sheet, perforated along its length, is provided internally in each tube. This sheet serves to ensure that the boiling nuclei, which form when the temperature of the surface exceeds by a few degrees that of the saturation of the fluid, tend to form a thin film of overheated liquid adjacent to the surface, creating bubbles completely attached to the latter. When the temperature of the hot surface is near the saturation temperature of the refrigerant fluid the heat is transferred by convection current to the free surface whence evaporation occurs.

The thermal resistance of this superheated liquid film is reduced by agitation and evaporation of the bubbles. Increase in the temperature of the tube wall is accompanied by an increase in the quantity of bubbles, which, in their turn, cause a big increase in the heat flow. As the heat flow, or the difference in temperature, is further increased more and more vapour is formed until a point is reached at which the flow of liquid around the surface is interrupted, forming a cloud of vapour.

The preferred evaporator consists of a parallelepiped with rounded vertices, within which is a panel of the tubes, which are rectangular in form, whose upper and lower surfaces are formed by the fins which are curved and arranged to be opposite and symmetrical with regard to the central plane of the panel but are distributed in parallel form on each side surface.

In known evaporators, use is commonly made of panels of circular tubes which extend over the whole evaporator in coil form. These differ from the arrangement proposed by the invention which provides a bank or panel of horizontal tubes each

providing a single run, without interconnections between the runs, permitting the passage of the fluid from a saturated liquid reservoir at one end of the panel to a saturated vapour reservoir at the other end of the panel, independently for each tube. This increases the capacity of the evaporator by about 25% to 30%.

The tubes may each be constructed as a connected pair, being a double tube, or may each be a single tube with one or more intermediate dividing walls. Above and below, each said pipe has numerous curved fins, with narrow parallel separations, which increase very considerably the area available for heat transfer.

Where each tube has a single central intermediate dividing wall, the fins of each tube may each be correspondingly divided by means of a small central cut disposed approximately in register with the intermediate separating wall.

The fluids used in the evaporator are those used traditionally in conventional evaporator equipment for air conditioning and refrigeration, namely a refrigerant liquid (for example freon or ammonia) for passage through the tubes and ambient air as a heat interchange fluid which passes over the outer surfaces of the fins as a result of induced convection currents.

To increase the efficiency of the evaporator, sheets, which may be doubled, are inserted in zig-zag configuration within the tubes, being arranged transversely. At intervals along the lengths of the said sheets there are perforations or cuts that also form zig-zags which serve to produce slow turbulence which homogenises the molecules of the vaporised refrigerant.

Technically, the evaporator represents an improved construction, as much in its structure as in its characteristics, in that it has increased efficiency and capacity per ton of refrigeration or per unit of volume, as compared with known evaporators of similar size and capacity.

The fins may be constructed by machining from the same material as the tubes. They present a rigid form which allows access for means of cleaning between them, to eliminate dirt or foreign matter which may diminish the thermal conductivity of the fins, that is to say, they are shaped so as to prevent distortion and deterioration through bad handling during cleaning operations.

The invention will be described further, by way of example, with reference to the accompanying drawings, in which:—

Fig. 1 is a sectional end elevation illustrating diagrammatically a preferred embodiment of the evaporator of the invention, the section corresponding to the line I—I of Fig. 2;

Fig. 2 is a diagrammatic sectional side elevation of the evaporator of Fig. 1, the section being taken on the line II—II of Fig. 1;

Fig. 3 is a sectional underneath plan taken as indicated by the line III—III of Fig. 2;

Fig. 4 is a diagrammatic sectional detail taken as indicated by the line IV—IV in Fig. 5; and

Fig. 5 is an enlarged detail of the end of one of

the tubes of the evaporator as indicated by the circle in Fig. 1.

As can be seen from the drawings, the preferred embodiment of the evaporator of the invention comprises a panel or bank of tubes 10, each of rectangular cross-section, which fit by their ends 16 tightly into respective openings in head plates 7 and 17 which provide opposed end faces of the tube panel or bank. Each tube 10 has a respective internal dividing wall 9 which partitions the interior of the tube into two ducts. Naturally, it will be understood that a similar arrangement could be achieved by securing together two rectangular tubes to form a double tube. Each tube 10 has integrally formed therewith respective fins 6. Each such fin 6 is formed with a recess 20 substantially in register with the respective internal dividing wall 9. Inside each duct of each tube 10 is a respective zig-zag sheet 8 which serves as a static turbulence generator.

From Fig. 2 it can be seen that the holes or openings in the head plates 7 and 17 are punched out to form respective lips around each said opening and that the lips on the head plate 7 protrude outwardly of the panel or bank of tubes, whilst those on the head plate 17 protrude inwardly. This figure also shows how the fins 6 project principally above and below the respective tubes 10 and are each of curved configuration. Fitting to the head plates 7 and 17 are cover plates 21 and 22 respectively, the plates 7 and 21 forming a reservoir 12 at one end of the evaporator and the plates 17 and 22 forming a respective reservoir 11 at the other end of the evaporator. The cover plates 22, 21 are formed with entry and exit holes 14 and 15 respectively for refrigerant (not shown), and the cover plate 22 is also formed with a drain hole 19 for draining the evaporator when it may be necessary to draw off the refrigerant for example when internal cleaning is to be carried out. The cover plates 21, 22 are formed with stiffening ribs 13.

From Fig. 3 it can be seen that the panel or bank of tubes has the tubes 10 arranged in aligned pairs formed by two rows of the tubes separated by a central space through which air can pass for heat transfer. This figure also shows the separation of the fins 6 at the ends of the tubes and the fact that such fins extend obliquely relative to the longitudinal directions of the tubes; furthermore, the tubes 10 are arranged

symmetrically relative to the central plane of the panel or bank of tubes with the angles of the fins at one side of the central plane being opposite to those at the other side of said plane.

Figs. 4 and 5 illustrate the structure of the tubes 10 in somewhat greater detail, although the spacing of the fins 6 is somewhat exaggerated in Fig. 4 and the zig-zag sheet 8 is still shown only relatively diagrammatically. Fig. 5 shows more clearly the rectangular cross-section of the tube 10 with its fins joined to it, and the zig-zag sheets 8 inserted internally of its two ducts. Fig. 4 serves to show perforations 24 in zig-zag form, provided in each sheet 8 as well as the thickness of the tube 10 and the fins 6 distributed over its upper and lower surfaces.

CLAIMS

1. A liquid-type evaporator characterised in that it comprises a panel or bank of tubes each having fins joined to them and each containing a static turbulence generator comprising a sheet bent to zig-zag configuration and having along its length perforations in zig-zag form.

2. An evaporator as claimed in claim 1, characterised in that it includes two reservoirs, for liquid refrigerant, disposed at each end of the panel or bank, these reservoirs comprising respective head plates into which the respective ends of the tubes are sealed.

3. An evaporator as claimed in claim 1 or 2, wherein the tubes are double tubes or are provided with partitions and are in rectangular section arranged in rows to form the panel or bank which serves as a body of the evaporator in the shape of a parallelepiped.

4. An evaporator as claimed in claim 3 wherein the tubes are arranged with a separation therebetween, for the circulation of an air current as a means of heat transference by convection, to produce, across the fins, by conduction, an increase in refrigerant temperature, to accelerate evaporation thereof in the tubes.

5. An evaporator as claimed in any preceding claim characterised in that the fins are distributed in substantially parallel fashion on each side above and below the pipe and each having a curvature which provides an angle of incidence with the current of air to improve the heat transference between the air and the refrigerant.

6. A liquid-type evaporator substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.